The Madras Agricultural Journal

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CONTENTS

	Page
Editorial	295
Original Articles:	
1. Recent Developments in the Chemotherapy of Plant Diseases ... ... by G. Rangaswami	297
2. The Intake of Silica by the Rice Plant with Reference to Blast Disease ... by S. Venkatachalam	304
3. Recent Advances in Agriculture with Special Reference to Weed Control ... by T. R. Narayanan	310
4. Enzyme (Diastase) of Aspergillus and its Application to Malt Extract Production ... by S. Varadarajan	314
5. Recent Advances in Agricultural Extensión Work ... ... by S. N. Venkataraman	326
Research Note	329
Crop and Trade Reports	330
Weather Review	333
Departmental Notifications	334

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The Madras Agricultural Journal

Vol. XLI September 1954 No. 9

Editorial

Atom and Agriculture: With Einstein propounding $E = mc^2$ the atomic age came into being and Hiroshima had the first impact. This installed the era of terror and competitive research in weapons of destruction. But very soon people realised that mere creation of new and terrifying weapons of war to make mankind cower and shake in fear is not the be all and end all of the "Atom". The fact that the "Atom" can become one of man's servants is now admitted on all sides. "To hasten the day when the fear of the "Atom" will begin to disappear from the minds of people and the Governments of the East and the West" has now become the keynote of the policy of responsible Governments. The United States of America has consequently developed an Atom Pool Plan recently. This plan proposes to accelerate the peaceful uses of the "Atom," foster dissemination of atomic information and encourage the acquisition of new fundamental data and theory. India too, is not lagging behind as is evident from the recent pronouncements of our Prime Minister Pandit Nehru this month in the Lok Sabha that he proposes to call for a conference in Delhi some time in November this year, to study the possibility of using atomic energy for peaceful purposes.

It is agreed all around that there will be no lasting peace even with the atom and hydrogen bombs, until such time as conditions are so improved as to provide all the people of the world with a diet that is adequate for health and well being. As pointed out by Dr. Kesteven of F. A. O. with 68,000 extra people to be fed every morning we have to seriously think of utilising the "friendly atom". Governments of all countries being alive to this, the time is not far distant when the "Atom" will be utilised for Industry and Agriculture. But how is this "Atom" going to be harnessed for peaceful needs ? The initial attempts in the utilisation of atomic energy has been directed towards the production of abundant electrical energy. This requires that the fission reaction be made to proceed slowly under control and

not to liberate the energy, in a millionth of a second as in the atom bomb. This is certainly possible. By this the atomic fuel would provide three million times as much energy as the same weight of coal. If therefore, this transformation of atomic energy to electrical power could be done in power starved areas of the world, it would revolutionise farm power in agriculture.

In the United States, the Atomic energy Commission is supporting several schemes which have revolutionary potentialities of producing bumper crops unheard of before. The new process of obtaining both phosphatic fertiliser and Uranium from the Florida phosphate area is another achievement of the Atomic Energy Commission. Since World War II, the man hour requirements for growing 100 bushels of wheat have been reduced from 41 to 31 in U. S. A. For the first time in the annals of our country radio active isotopic material made available through the Indo-US Technical Aid Programme is being utilised at the Indian Agricultural Research Institute, New Delhi for studies in crop nutrition. Provision is also made for a central tracer laboratory for study, through tracer technique, the exact path of the metabolism of the different nutrients. Radio active phosphorus, as applied through phosphatic fertilisers, is first taken up for study. The other plant nutrients, nitrogen and potassium, would be studied subsequently. This new technique is bound to divulge hitherto unknown agricultural information.

At the Atomic Energy Commissions' Long-Island Laboratories near New York, many plant mutants with promising yield characteristics, have been developed with radio active cobalt. Through atomic radiation disease resistant strains of crops are reported to have been evolved. Tuber crops like potatoes are preserved for over two years through the use of atomic radiation. Pesticides and fungicides also come under the scope of development through the use of radio active isotopes, which track down the exact path of the chemicals in destroying the pests. Therefore, much scope of advancement in Agriculture is possible through the use of the "Atom" in the near future.

Recent Developments in the Chemotherapy of Plant Diseases *

by

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Introduction: The search for chemical substances to control plant and animal diseases started as soon as the microbial nature of the diseases was established early in the nineteenth century. At present several chemical substances, both inorganic and organic, are being used for combating these diseases. But the study of plant chemotherapy i. e. the treatment of plant diseases with chemicals which act within the host plant is a relatively recent subject and more and more attention is being paid to it at present in the United States of America and in England. An attempt is made here to bring together the latest developments and findings in plant chemotherapy.

Mode of action and the method of application of chemotherapeutants: It is generally understood that the symptoms of plant diseases are brought about either by the direct action of the pathogen on the host or from the host's reaction to the toxins produced by the pathogen. As a general rule the food supply available inside the plant tissue does not meet the specific requirements of the pathogen and so the establishment of the organism inside the host is prevented unless the host is susceptible to the specific organism. But in some cases the presence of fungistatic and fungicidal chemicals within the host tissue offers a natural resistance for the plant. The presence of protocatechuic acid in the scales of onions is a ready example. The object of chemotherapy is to introduce into the plant system some chemicals which can bring about the resistance or in other words immunize the plants against certain phytopathogens. These chemicals are known to act at least in two different ways: (1) by direct action on the pathogen and (2) by antidoting the toxins produced by the pathogen. Again, there are more than one way by which these effects are brought about by these chemicals. Some of them like hydrogen sulphide and hydrogen cyanide gases when applied externally are known to penetrate deep inside the host tissue and check the spread of the pathogen after it had entered the host. In this case the chemical is known to be a topical chemotherapeutant. When the chemical, applied to one part of the plant, diffuses to the other parts and arrest the pathogen or antidotes the toxins produced by it, it is known as a a systemic chemotherapeutant. In a few cases the chemical may change the degree of resistance of the host to the pathogen by bringing about a change in the metabolic activity of the plant.

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* Paper presented for the 1954 College Day and Conference Symposium on "Recent Advances in Agriculture".

There are several ways by which the chemotherapeutants are introduced into the plant system of which injection and translocation, soil treatment and root absorption and foliage application and leaf absorption are the important ones. Injection of the chemical into the stem was one of the common methods used by earlier workers, but in recent years the other two methods are reported to be more useful. In the case of Dutch elm disease it was found that when 8-quinolinol benzoate was applied to the roots, there was better control than when injected into the stem, the chemical injected into the stem was translocated readily in the longitudinal direction, but the radial and tangential transmission was very poor (Dimond *et al* 1949). Similar results have been reported for the bacterial blight of beans and X-disease of peach. There is enough evidence to show that the chemicals applied to the leaf surface are absorbed by the leaf and transmitted systematically, but the degree of absorption may vary with the chemical as well as the plant. Perhaps soil application of the chemical is the easiest and the best method but it has been found that many of the chemicals are less stable in the soil, thus warranting a serial application at periodical intervals. It is also known that certain chemicals and antibiotics lose their activity inside the plant which may be due to slow break down or dilution of the chemotherapeutant due to the effect of the growth of the plant. So the treatment in such cases may have to be repeated at closer intervals.

Most of the chemothrapeutants are known to be quite effective even in very small doses and it is more so with antibiotics which are effective at doses below I : 10,000. Some of them have been reported to be phytotoxic at higher levels, but the nonphytotoxic dosage, the time and frequency of treatment etc., are details to be worked out for a given set of conditions.

Organic Compounds as Chemotherapeutants: Several organic and inorganic compounds have been tested for their chemotherapeutic value in plants against fungal, bacterial and virus diseases but only a few of them were found to be effective. Some of the important diseases which have been successfully treated by the chemicals other than antibiotic substances are listed in Table I.

Antibiotics as Chemotherapeutants: Of the more than one hundred antibiotics so far reported to have been isolated from microorgaisms, only a small number has been tested in plants and among them only a few have been reported to be useful as chemotherapeutants. The action of antibiotics against plant viruses is at present a controversial topic as some workers believe that the virus principle is inactivated by the antibiotic as indicated in the *in vitro* experiments and others believe that they bring about a change in the host tissue resulting in the resistance of the plant to virus infection. The important fungal, bacterial and virus diseases of crop plants controlled by antibiotic chemotherapy are given in Table II.

TABLE I

Some of the important plant diseases controlled by chemotherapy

No.	Name of the disease	Casual agent	Chemotherapeutant	Authority
I	**Fungus Diseases:**			
1.	Dutch elm disease	*Ceratostomella ulmi*	(i) 8-quinolinol benzoate (ii) 2-carboxymethyl mercaptobenzo-thiazole salts	Dimond *et al* (1949) Dimond and Davis (1952)
2.	Wilt of tomato	*Fusarium lycopersici*	(i) 8-quinolinol sulphate (ii) Na and K 2-benzothiazolyl-thio-glycolates	Stoddard and Dimond (1951) Dimond and Davis (1953)
3.	Wilt of carnations	*Fusarium* sp.	4-chloro-3, 5-dimethylphenoxye-thanol; 2-norcamphane metha-nol; 8-quinolinol sulphate	Stoddard and Dimond (1951)
4.	Wilt of greenhouse stock (*Matthiola incana*)	*Rhizoctonia* sp.	8-quinolinol sulphate	Stoddard and Dimond (1951)
5.	Root rot of Vanda orchids	*Fusarium* sp.	T. M. T. D.	Murakishi (1953)
6.	Wilt of egg plants	*Verticillium* sp.	2-carboxymethylmercapto-benzo-thiazole salts	Dimond and Davis (1953)
7.	Oak wilt	*Chalara quercina*	Disodium ethylene bisodium car-bamate + 2-mercaptobenzothia-zole; 8-hydroxyquinoline etc.	Hoffman (1952)
8.	Early blight of tomato	*Alternaria solani*	(i) 4-nitrosopyrazoles (ii) 2-carboxymethylmercapto-benzo-thiazole salts (iii) 1-p-sulfamylphenyl-3, 5-dime-thyl-4-nitrosopyrazole; 2, 4, 6-trichlorophenoxy acetic acid	McNew and Sundholm (1949) Dimond and Davis (1952) Stubbs (1952)

No.	Name of the diseaso	Casual agent	Chemotherapeutant	Authority	
9.	Chocolate leaf spot of beans	*Botrytis cinerea* and *B. fabae*	(i) Aryloxyaliphatic acids (ii) 2, 4, 6-trichlorophenoxyacetic acid (iii) Mono-, di-, and trichloro-beta-naphthols	Crowdy and Wian Crowdy and Elizabeth Byrde *et al*	(1951) (1952) (1953)
10.	Stem rust of wheat	*Puccinia graminis tritici*	(i) Calcium sulfamate (ii) Sulphdiazine; 3-sulphanilamile-6-methyl pyridazine	Livingston Hotson	(1953) (1953)
II	**Bacterial Diseases:**				
1.	Bacterial blight of beans	*Xanthomonas phaseoli*	Salicylic acid; Auamine	Dimond and Stoddard	(1948)
.2.	Crown gall of fruit trees	*Bacterium tumefaciens*	Sodium dinitro-o-cresylate	Ark	(1941)
III	**Virus Diseases:**				
1.	X-disease of peach	virus	Quinhydron; hydroquinone; 8-quinolinol sulphate; p-nitrophenol; p-amino-benzene sulphamide	Stoddard	(1947)
2.	Leaf roll of potato	virus	2, 4-dichlorophenoxyacetic acid 2-methyl-4-chlorophenoxy	Lock Limasset *et al*	(1948) (1948)
3.	Potato virus X and Y	virus	acetic acid		
4.	Tobacco mosaic	virus	(i) 4-chloro-3, 5-dimethylphenoxy ethanol (ii) Thiouracil	Davis Nichols	(1952) (1954)

TABLE II

Plant diseases controlled by antibiotic chemotherapy

No.	Name of the disease	Causal agent	Chemotherapeutant	Authority	
I	**Fungus Diseases :**				
1.	Early blight of tomato	*Alternaria solani*	Griseofulvin	Brian	(1952)
2.	Late blight of potato	*Phytophthora infestans*	Terramycin	Bonde	(1953)
3.	Seedling blight of oats and barley	*Helminthosporium victoriae*	Helixin B	Leben *et al*	(1953)
4.	Wilt of tomato	*Fusarium oxysporum* var. *lycopersici*	Thiolutin	Gopalakrishnan & Jump	(1952)
5.	Stem rust of wheat	*Puccinia graminis tritici*	Actidione	Livingston	(1953)
6.	Mildew of oats and barley	*Erysiphe graminis*	Griseofulvin	Brian	(1952)
II	**Bacterial Diseases :**				
1.	Crown gall of fruit trees	*Bacterium tumefaciens*	Penitalin	Repert & Hawas	(1951)
2.	Gall on tomato	*Agrobacterium tumefaciens*	Aureomycin	Blanchard	(1951)
3.	Bacterial blight of beans	*Xanthomonas phaseoli*	Streptomycin	Mitchell *et al*	(1952)
4.	Leaf drop of fruit trees	*Xanthomonas pruni*	Streptomycin ; Terramycin	Dunegan *et al*	(1953)
III	**Virus Diseases :**				
1.	Tobacco necrosis	virus	(i) Terramycin (ii) Trichothecin	Leben & Fulton	(1952)
2.	Tobacco mosaic	virus	Trichothecin	Bawden & Freeman	(1952)
3.	Tomato bushy stunt	virus	Trichothecin	Bawden & Freeman	(1952)

Discussion: Though the chemotherapy of plant diseases is known to be one of the most important methods of plant disease control particularly so for systemic diseases, comparatively little attention has been paid to it so far. Perhaps this is due to want of sufficient knowledge on the chemotherapeutic agents and also phytotoxic nature of those known to be antimicrobial. Further the translocation of the chemicals introduced into the plant is brought about mostly by osmosis and is very slow as compared to the translocation in the blood stream in animal which is more conducive and effective in combating pathogens. With the increasing knowledge on the chemotherapeutic value of some of the organic substances and the etiology of the disease more and more attention is being paid to overcome the obstacles observed in previous years. Moreover it has been recently observed that some of the chemicals which did not show much antimicrobial property *in vitro* proved to be quite useful as chemotherapeutic agents. Davis and Dimond (1953) found that the plant growth regulators, 2,4-D, α-naphthalene acetic acid and indol-3-acetic acid, which had relatively low fungitoxicity *in vitro* when applied to the tomato plants four to ten days prior to inoculating with *Fusarium oxysporum*, the wilt disease was reduced or prevented. A change in the host metabolism showing reduced sugar content of tissues was recorded. The longer the interval between treatment and inoculation the more potent was the chemotherapuetic effect. Gupta and Price (1952) obtained similar results when the culture filtrate of *Trichothecium roseum* was tested against Southern bean mosaic. These findings have opened a new line of approach in chemotherapy of plant diseases, wherein it is required to test all chemicals for activity irrespective of their antimicrobial property *in vitro*. In this connection one important precaution to be observed is to see that the quality of the produce is not adversely affected by the chemotherapeutants. It is hoped that a vigorous approach from the biological as well as chemical aspects of these complicated problems is bound to yield better results.

REFERENCES

Ark, P. A., (1951)—*Pl. Dis. Reptr.* **35** : 44.

Bawden, F. C. and Freeman, G. C., (1952)—*J. Gen. Microbiol.* **7** : 154-168.

Blanchard, F. A., (1954)—*Phytopathology* **41** : 954-958.

Bonde, R., (1953)—*Phytopathology* **43** : 463-464.

Brian, P. W., (1952)—*Ann. appl. Biol.* **39** : 434-438.

Byrde, R. J. W., Crowdy, S. H. and Woodcock, D., (1953)—*Ann. appl. Biol.* **40** : 152-165.

Crowdy, S. H. and Elizabeth, M. D., (1952)—*Phytopathology* **42** : 127-131.

Crowdy, S. H. and Wain, R. L., (1951)—*Ann. appl. Biol.* **38** : 313.

Davis, D., (1952)—*Phytopathology* **42** : 465.

Davis, D. and Dimond, A. E , (1953) —*Phytopathology* **43** : 137-140.

Dimond, A. E. and Davis, D., (1952) —*Phytopathology* **42** : 7.

— and — (1953) —*Phytopathology* **43** : 43-44.

Dimond, A. E , Plumb, G. H., Stoddard, E. M. and Horsfall, J. G., (1949) — *Conn. Agr. Expt. Sta. Bull.* **531**.

Dimond, A. E. and Stoddard, E. M., (1948) —*Phytopathology* **38** : 313.

Dunegan, J. C., Wilson, R. A. and Morris, W. T., (1953) —*Pl. Dis. Reptr.* **37** : 604-605.

Gopalakrishnan, K. S. and Jump, J. A., (1952) —*Phytopathology* **42** : 338-339.

Gupta, B. M. and Price, W. C., (1952) —*Phytopathology* **42** : 45-51.

Hoffman, P., (1952) —*Phytopathology* **42** : 11.

Hotson, H. H., (1953) —*Phytopathology* **43** : 659-662.

Leben, C., Arny, D. C. and Keitt, G. W., (1953) —*Phytopathology* **43** : 391-394.

Leben, C. and Fulton, R. W., (1952) —*Phytopathology* **42** : 331-335.

Limasset, P., Levieil, F. and Sechet, M., (1948) —*Compt. Rend.* **227** : 643-645.

Livingston, J. E., (1953) —*Phytopathology* **43** : 496-499.

Lock, S. B., (1948) —*Phytopathology* **43** : 496-499.

McNew, G. L. and Suudholm, N. K., (1949) —*Phytopathology* **39** : 721.

Mitchell, J. W., Zaumeyer, W. J. and Anderson, W. P., (1952) —*Science* **115** (2979) : 114-115.

Murakishi, H. H., (1953) —*Bull. Pacific Orchid Soc. Hawaii* **11** : 7-10.

Nichols, C. W., (1954) —*Phytopathology* **44** : 92-93.

Repert, A. F. and Hawas, L. J., (1951) —*Rev. Path. Veg.* **30** : 25-29.

Stoddard, E. M., (1947) —*Conn. Agr. Expt. Sta. Bull.* **506**.

Stoddard, E. M., and Dimond, A. E., (1951) —*Phytopathology* **41** : 337-340.

Stubbs, J., (1952) —*Ann. appl. Biol.* **39** : 439-441.

The Intake of Silica by the Rice Plant with Reference to Blast Disease *

by

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Introduction: The blast disease caused by the fungus Piricularia Oryzae is the most serious disease of the rice crop, but is prevalent only on certain strains of paddy while others are immune to it. Hence the effective control of the disease at present is only through the use of resistant strains. Among the Madras strains, Co_4 (Coimbatore 4) is highly resistant even under worst conditions while the variety Adt_{10} (Aduthurai 10) is highly susceptiable to the disease. The latter strain is however a high yielder and hence very popular in the Tanjore Delta.

In modern times with the advancement of science many of the characters such as resistance and other factors which are indissoluble Mendelian factors of inheritance, located in the genes of chromosomes have been explained through enzymology in terms of certain set chemical reactions resulting in definite chemical compounds. Hence this inheritance of resistance to blast, located in specific strains were aimed to be studied in terms of possible chemical constituents in the strains which bestowed on the strains the disease resistance.

A perusal of literature on the subject of disease resistance in general and with special reference to paddy blast revealed a considerable volume of experimental evidence in favour of a plausible relationship of silica in the plant to disease resistance. Thus Onodera (1), Miyake and Adachi (2), Kawashima (3), Ikari and Kubota (4), Miyake and Ikeda (5), Ito and Hyashi (6) have all correlated silica in the rice plant to blast resistance. Suzuki (7) examining through a microscope the cross sections of the leaves and pedicels of spikes of the rice plants recognised that the outermost layers of the epidermal cell walls contained great amounts of silica and that these silicated cells were greater in the resistant variety than in the susceptible one.

A preliminary study conducted on the anatomical and chemical aspects taking pre-harvest samples of plant material belonging to the varieties Co_4 and Adt_{10} growing under identical conditions revealed the following features:—

1. *Anatomical Studies:* A number of epidermal peelings of leaves and stems at the neck of earhead of the two varieties obtained by macerating the tissue with concentrated nitric acid and potassium chlorate (as bleaching agent) were examined under the microscope and were found

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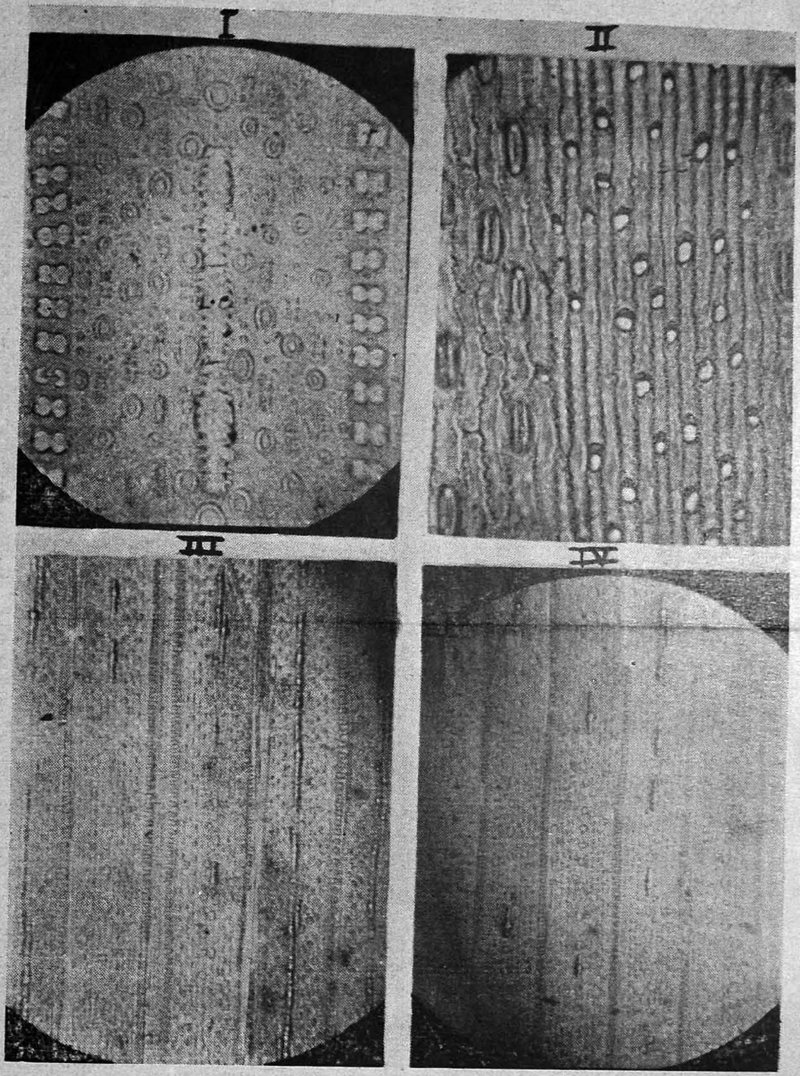
* Awarded Venkataswamy Naidu's Silver medal on the College Day 1954.

To face page 304:



Microphotograph of:

PLATE I: Leaf epidermis of rice plant under high power of microscope showing the silicated long cells (l. c.) and silicated short cells (r).

PLATE II: Stem epidermis under high power showing silicated short cells (s. c.).

PLATE III & IV: Leaf epidermis under low power of Co_4 and Adt_{10} respectively showing comparatively higher silication in the variety Co_4 than Adt_{10} with reference to the silicated long cells.

to exhibit extensive silication in the form of short and long cells. These silicated epidermal cells were easily detected under the microscope when stained with phenol or chloriodide of zinc and were found to be greater per unit area of Carl Ziess 7×40 in the resistant variety Co_4 than in the susceptible one Adt_{10}. Plates I to IV show the nature of silicated cells in the leaf and stem epidermis.

2. *Chemical Studies:* Chemical analysis of leaves and stems for silica content showed that the susceptible variety contained more silica than the resistant one.

Thus while the findings of the anatomical studies made on the leaves and stems were in line with those of the Japanese workers, the chemical analysis gave results of a contradictory nature. Hence it was decided to study in detail the intake and distribution of silica in the two varieties of rice plant.

Material and Method: The rice plants were raised in pots and the two series of pots viz., Co_4 and Adt_{10} were maintained under identical conditions of irrigation etc.,

Chemical Analysis: Samples of plant material viz., leaves, stems roots, panicles and whole plants, were collected at different stages of growth and were analysed for dry matter, ash and silica. Estimation of silica was done using hydrofluoric acid on the sulphated ash.

Discussion of results: The results of analysis of the plants and plant parts of the varieties Co_4 and Adt_{10} sampled at different stages of growth given in table I present the following features :-

1. *General:* There is a continuous absorption of silica during the life of the plant upto the grain formation stage after which the absorption ceases. The leaves and stems attain their maximum silica content by the time the flowering has taken place and the grains begin to set. The panicles show an increase in silica content even after grain formation stage and there is a coincidental fall in the silica content of leaves and stems. Thus there is a certain amount of evidence of movement of silica from one part of the plant to another. The results of analysis of roots are irregular especially in the case of Adt_{10} at flowering and this is reflected in the whole plant analysis.

2. *Silica content of leaves, stems etc, with reference to resistance to blast:* When the silica content of leaves and stems is expressed as percent of ash, dry matter or green matter, the resistant variety does not show higher value than the susceptible variety, especially after the plants have come to maturity as was also observed in the preliminary studies. The results of analysis of whole plant sample show that the plants sampled at tillering stage show greater silica content in the resistant

variety than the susceptible variety. Thus while there is an indication of the resistant variety having more silica than the susceptible variety when the plant as a whole is considered during the vegetative phase, the analysis of leaves and stems after the plants have come to maturity, do not show greater silica content in the resistant variety than in the susceptible one.

TABLE I. Showing the silica content in leaves, stems etc. of the varieties Co_4 and Adt_{10} at different stages of growth
(Percentages)

Material analysed and stage of growth	SILICA CONTENT					
	Ash basis		Dry Matter basis		Green Matter basis	
	Co_4	Adt_{10}	Co_4	Adt_{10}	Co_4	Adt_{10}
1. *Leaves:*						
(a) Mature Plant Stage	55·02	54·46	10·86	10·70	3·14	2·77
(b) Flowering Stage	63·58	68·22	12·75	16·48	3·73	4·41
(c) Grain formation ,,	63·76	71·34	12·16	18·52	4·30	5·81
(d) Harvest ,,	57·11	60·16	11·24	12·12	4·11	4·32
2. *Stem:*						
(a) Mature Plant Stage	30·78	37·87	5·71	8·18	0·97	1·26
(b) Flowering ,,	48·09	50·22	8·99	12·45	1·55	2·05
(c) Grain formation ,,	48·84	50·19	8·32	13·33	2·02	2·93
(d) Harvest ,,	47·88	50·06	7·97	10·14	1·98	2·22
3. *Panicles:*						
(a) Flowering Stage ,,	53·09	65·72	4·19	8·19	1·13	2·14
(b) Grain Formation Stage	76·37	77·47	9·47	8·33	5·74	5·04
(c) Harvest ,,	82·81	79·73	17·17	11·32	12·28	9·06
4. *Roots:*						
(a) Mature Plant Stage	10·69	5·55	1·50	0·76	0·30	0·15
(b) Flowering ,,	29·20	30·40	3·95	4·37	0·66	0·83
(c) Grain Formation Stage	40·87	23·72	5·46	4·47	0·90	0·78
(d) Harvest Stage	35·75	38·68	5·23	5·79	0·82	0·91
5. *Whole Plants:*						
(a) Beginning to tiller	31·23	24·29	5·07	4·27	0·79	0·58
(b) Mature Plant Stage	37·82	43·69	6·20	8·99	1·23	1·54
(c) Flowering Stage	52·78	48·52	9·45	8·99	1·69	1·66
(d) Grain Formation Stage	53·83	59·54	9·84	13·07	2·80	2·95

TABLE II. Showing intake of silica during different periods of growth as percent of total intake
(Calculation based on silica on ash figures in table I)

	Leaves		Stems		Panicles	
	Co_4	Adt_{10}	Co_4	Adt_{10}	Co_4	Adt_{10}
1. Upto Maturity ..	*86·3*	*76·3*	63·0	75·4	—	—
2. Maturity to flowering ..	13·4	19·9	*35·4*	*24·6*	*64·1	82·4*
3. Flowering to grain formation ..	0·3	4·4	1·6	Nil	*28·1*	*14·7*
4. Grain formation to harvest ..	Nil	Nil	Nil	Nil	7·8	2·9

* Represents silica content at flowering as percent of total intake.

3. *Intake of silica during critical periods of vulnerability of the plant parts to fungus attack expressed as percent of total intake:* The critical periods of vulnerability to attack differ with the different parts of the plant. Thus during the early stages of growth of the plant the foliage is more exposed to fungus attack than the stems, the latter being covered by leaf sheaths. The time when the stem is really and badly exposed to attack is when it emerges through the flag leaf bearing the earhead i. e., at the time of flowering. At that time the stems are not only well exposed but are also very juicy conducting nutrients to panicle. Thus under actual field conditions we find that the stems mainly suffer the fungal attack at the neck of the earhead (portion below earhead) at flowering stage while the foliage are attacked much earlier, even from the nursery stage. Hence it would be but right to find out if there is any correlation of silica intake at these critical periods with the resistance of the plant to disease. Table II gives data pertaining to this. It is found from the data therein that a definite correlation does exist between the rate of intake during the critical periods of vulnerability to attack and the resistance. Thus we find during the vegetative stage when the leaves are more exposed to attack the intake of silica in leaves is greater in the resistant variety than in the susceptible one (86% of total in Co_4; 76% in Adt_{10}). The variety Co_4 is a longer duration one (180 days) than Adt_{10} (165 days) and the more rapid intake of silica is not a function of an enhanced rate of maturation processes. Again from maturity to flowering when as mentioned before the stem is more exposed to attack, the intake by this part of the plant is greater in the resistant variety than in the susceptible one (35% in Co_4; 25% in Adt_{10}). It is similarly high in the panicles of the resistant variety from the flowering stage to harvest. The panicles of the resistant variety show greater intake than the susceptible one (35 9% in Co_4; and 17·6% in Adt_{10}). Thus, while the silica in the plant when considered as mere total contents at a particular date does not give a correct indication of the role of silica in the resistance of the plant to disease, the representation of the intake during the critical periods of vulnerability to fungal attack expressed as percentage of total intake gives the correct picture.

TABLE III. Showing the dry matter percentage, in leaves, stems etc. at different stages of growth

Stages of growth	Leaf		Stem		Panicle		Root	
	Co_4	Adt_{10}	Co_4	Adt_{10}	Co_4	Adt_{10}	Co_4	Adt_{10}
1. Mature plants	28 98	25·84	16·92	15·38	—	—	20·20	19·80
2. Flowering	29·27	26·74	17·16	16·46	27 08	26·13	19·69	18·94
3. Grain formation	35·40	31·39	24·30	22·00	60 02	60 57	16 38	17·36
4. Harvest	36·58	35·73	24·84	21·84	71·56	79 99	15·63	15·63

4. *Presentation of silica on surface area basis in leaves:* Another interesting feature is presented by the data of dry matter contents of the parts analysed as given in table III. It is seen from the data in this table that at all stages of growth, the leaves, stems etc., show a greater dry matter percent in the resistant variety Co_4 than in the susceptible one Adt_{10}, exceptions being very few, noticed in roots and panicles only. The greater amount of dry matter in leaves, stems etc., of the variety Co_4, it was speculated would mask the results of analysis for silica when represented on the basis of weight. If this be acceded, the presentation of silica on the basis of the area of the surface on which it is distributed would give a better picture of silication, as silica is mostly confined to the epidermal regions. To confirm this, a study was made on the leaves of the two varieties collected at harvest stage.

Two sets of 50 leaves were collected for each of the two varieties from the bulk sample used for chemical studies. Every 10th or 15th leaf from the bulk was taken according to the size of bulk. The surface area was measured by using a planimeter on the outlines of leaves traced on tissue paper. Silica was estimated as usual after drying the material and the results expressed on area basis. The results are given in table IV.

TABLE IV. Showing silica in leaves represented on area basis

No.	Particulars	Experiment I		Experiment II	
		Co_4	Adt_{10}	Co_4	Adt_{10}
1.	Green weight of 50 leaves in grams	23·1390	18 1630	22·9550	17·6340
2.	Dry weight ,, ,,	8·4650	6.4950	8·4404	6·1240
3.	Ash weight ,, ,,	1·5810	1·3780	1·5770	1·2990
4.	Silica in 50 leaves in milligrams	952 0	784 0	949 0	742 0
5.	Total surface area in sq. cm.	2742	2472	2534·4	2420
6.	Silica per 100 sq. cm. of leaf surface in milli grams	34 85	31·85	36·60	30·70
7.	Silica as percent of dry matter	11·25	12·12	11·25	12·12

It is seen from the data given in table IV that the differences in green weight, dry weight and ash weight is considerable in the two varieties, Co_4 showing higher value than Adt_{10}. It is also seen that the silica content per unit area is greater in Co_4 than in Adt_{10}.

Conclusion: 1. Chemical analysis of leaves and stems sampled at different stages of growth show that the silica content when represented on the basis of dry weight, green weight or ash weight bears no correlation to the resistance of the plant to blast i. e., the resistant variety Co_4 does not show higher silica content than the susceptible one Adt_{10}. However, when the silica intake in leaves, stems and panicles during the critical period of vulnerability to fungal attack is expressed as percent of total intake, there is a direct correlation between silica and resistance, the resistant variety Co_4 showing greater intake than the susceptible variety Adt_{10}.

2. The computation of silica on the basis of surface area, based on chemical analysis, gives a better picture of the silica distribution in the different parts of plant than when represented on the basis of weight and this is in line with the observation made in the anatomical studies in which the resistant variety showed more silicated cells.

3. Hence it is evident that consideration of total silica does not give the correct picture of the role of silica in the resistance of the rice plant to blast disease. But from this study it was established that the rate of absorption of silica by the plant parts during the critical period of vulnerability to fungal attack is the factor which decides resistance or susceptibility of a rice variety.

Summary: The blast disease on paddy caused by the fungus Piricularia Oryzae though the most serious disease of the rice crop is not prevalent on all strains of paddy. Paddy strains like Co_4 are completely immune to it. It was sought to find out criteria of a chemical nature that would indicate resistance or susceptibility. A perusal of literature on the subject showed all evidence in favour of silica as the factor responsible for resistance. However, preliminary chemical analysis of plants of the resistant variety Co_4 and a susceptible one Adt_{10} showed no greater silica content in Co_4 than in Adt_{10}, though the anatomical studies on the epidermal peelings of leaves and stems showed greater number of silicated cells in Co_4 than in Adt_{10}. Hence, a detailed study on the intake of silica by the two varieties was taken up. Plants were raised in pots. Chemical analysis for silica content was done on leaves, stems, etc. at different stages of growth and the results expressed as (i) total intake at different stages on the basis of dry matter weight etc., (ii) intake during critical periods of vulnerability to fungal attack as percent of total intake and (iii) silica content on the basis of surface area of leaves. The following conclusions were drawn:

1. The total intake of silica by leaves and stems is not correlated with the resistance to disease.

2. The intake of silica during the critical period of vulnerability of the plant to fungal attack is directly correlated with the resistance to disease, the resistant variety showing more of intake than the susceptible one.

3. Silica as assessed on the basis of area instead of on dry matter basis gives a better picture of the distribution of silica in the leaves and confirms the findings made by the anatomical studies in which greater number of silicated cells per unit area was observed in the resistant variety than in the susceptible one.

Acknowledgment: The work was carried out in the laboratory of the Government Agricultural Chemist, Agricultural College and Research

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LITERATURE CITED:

1. Onodera I. J. Sci. Agri. Soc. No. 180, 606, 1927 (Japanese—Cited by Suzuki H 7).
2. Miyake, Y. and Adachi, M. J. Bio. 1, 223, 1922 (Cited by Suzuki, H. 7)
3. Kawashima, R. J. Of Sci. and Manure 11, 86, 1927 (Japanese—Cited by Suzuki, H. 7)
4. Ikari and Kubota. J. Sappor. Soc. Agri. and For. XXI, 97, 92, 1930 (Japanese Cited by Suzuki, H. 7)
5. Miyake, Y. and Ikeda, J. S. Sci. Sol. and Man. VII, 53, 1932 (Japanese—Cited by Suzuki, H. 7)
6. Ito. S. and Hyashi, H. J. Sappor. Soc. Agri. and For. XXI, 103, 78, 1931 (Japanese—Cited by Suzuki, H. 7)
7. Suzuki, H. J. Coll. Agri. Tokyo, 13, 45—236, 1934 (*English*)

Recent Advances in Agriculture with Special Reference to Weed Control

by

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Introduction: Taking "recent" to mean within the past ten years, a number of new developments can be enumerated as constituting advances in the field of agriculture. But from the view-point of plant physiology, these developments can be narrowed down to just three or four, viz., in the field of plant nutrition with special reference to micro-nutrients, photoperiodism, hydroponics, dormancy and growth-hormones. The last one is perhaps the most outstanding, but within the scope of this paper it is proposed to discuss only a single aspect of growth hormones, namely their potentialities as weedicides.

*Paper read at the 1954 College Day and Conference Symposium on "Recent Advances in Agriculture."

Growth Hormones: The discovery of the hormone system in plants and the later isolation and synthetic production of numerous substances which regulate growth in plants, has been one of the outstanding achievements in Plant Physiology. The term "Hormones" has been used for these substances (From the Greek *Hormacin*: to set moving) as they were believed to be produced in one portion of the plant body and manifest their effects in other portions, but it is preferable to use the term "growth-regulators" or "growth-regulating substances" when the group of synthetic chemicals is referred to. These compounds have an astonishingly diverse range of effects upon plants and new uses are being constantly added to, as more. is known about the nature of the responses that these compounds can produce. They are capable of regulating growth in some part or other of the plant body, and in contrast to the indirect effects of insecticides and fungicides that merely serve to protect the plants from injury, these compounds act directly upon the plant metabolism in a physiological sense, although in a manner that is distinct from fertilizer materials that supply major or minor nutrient elements.

A large-scale use of plant growth-substances has fostered within the last ten years, a million-dollar business in the United States of America, Great Britain and other countries of the West. Thus "2, 4-D," which was once used only in minute doses in the laboratory was produced in 1948 to a total of nearly thirty million pounds, mainly for for weed eradication.

The use of growth-regulating chemicals for encouraging better and quicker rooting of plant cuttings is now quite well-known and is used generally by gardeners in other lands. The main limitation to a still wider use of these chemicals (among which β-indole-butyric acid is the most popular) lies in the fact that most of the horticulturally valuable plants come under the group of "difficult to root" plants, where growth-regulators have only a moderate effect.

Weed Control by growth-regulating chemicals: In 1943—1944 chemicals of the "phenoxy" type were studied intensively as part of secret, war-time research in Great Britain, towards perfecting chemicals for destroying enemy crops. These chemicals act by over-stimulating the plants' physiological processes so much as to "burn themselves out", so to speak. The compounds "2, 4-D" and "MCPA" were the most effective; they were able to kill off all broad-leaved dicotyledonous weeds growing in cereal crops when used at dosages of 1 to 4 lb. per acre without affecting the cereal crops and thereby came to be known as selective weedicides. Weed killing is at present by far the most important practical use of these "hormone" chemicals.

There has been in recent years quite a phenomenal increase in the use of "2, 4-D" as a weedicide all over the world (except perhaps in

India). The second in importance is the use of alpha-naphthalene-acetic acid to prevent pre-harvest drop of apples. "2, 4–D" alone has a potential annual market of more than 500 tons and can soon be expected to top the list of all organic agricultural compounds.

Since "2, 4-D" and allied compounds are less effective against grass weeds, new weedicide chemicals are being tested and very recently one or two have been claimed to be quite effective.

Indian work: "2, 4-D" or its near analogue, "M.C.P.A." have been found extremely effective in destroying water hyacinth by a number of workers viz. Mitra. (1948), Thomas and Srinivasan (1949) Lal and Scott-Padwick (1948). Prasad (1952) found that Crag Herbicide was effective in killing *Orobanche* in tobacco without injury to tobacco plants. "2:4-D" and "MCPA" formulations like Agroxone, Fernoxone, and Dicotox were found very effective against *Convolvulus arvensis* (Bindweed) and *Chenopodium album* but they were ineffective at the strengths tried, against Spurrey. Against grass type weeds, Kalamkar and Ekbote (1953) found that "CMU" at 20 lb. per acre was effective against *Saccharum spontaneum*, but "TCA" was not effective.

At Coimbatore, work is proceeding since 1953 on weed control by chemical herbicides. A mixture of "2, 4-D" and "MCPA" in the form of the sodium salts at 5 lb. rate in 50 gallons per acre gave 90 to 100 % mortality in *Cyperus rotundus* (Nut grass) in the course of 3 to 4 weeks from spraying date and regrowth was prevented for a period of nearly three months. A combination spray of these two chemicals mixed with diesel oil gave a complete kill of *Cyperus* within two weeks. Against *Hariali* (*Cynodon dactylon*) too, well-established stands could be killed off in 4 to 5 days time by 2, 4–D" and pentachlorophenol (PCP) in diesel oil. "PCP" is unable to kill off the underground portions, but "2, 4-D" can destroy them to some extent. The plots so treated were free of *hariali* for over two months. For complete eradication a combination of herbicidal and cultural measures seems to be necessary.

A good deal of valuable information has been gathered already on the effect of numerous weedicide chemicals on a wide variety of weeds and the work is being continued.

A new method has been devised and used for the detection of toxicity left in the soil when the land is sprayed with herbicides, to see when it is safe to use that land again for cropping. The method is based upon the reduction of growth in cucumber seedlings by varying concentrations of growth-regulating substances. From these studies it was noted that residual toxicity was less persistent in "MCPA" than with "2, 4–D"

Work is also in progress at Coimbatore on the control of *Striga* by the use of the hormone type of weedicides.

It is hardly necessary to stress the fact that a great deal of work still remains to be done, in testing the latest herbicides against the major weeds in India and especially in Madras, in the case of trouble-some and persistent weeds like Hariali, Kikuyu grass and Cyperus. Spurrey and Oxalis are two bad weeds on the Hills for which effective and inexpensive control measures are yet to be found. Woody weeds like Lantana and Gorse are also quite a problem in certain areas. These require a different type of herbicides and much work is needed before effective control measures can be suggested.

A vast unexplored field of work lies before us in this weed control problem. The importance of fundamental research is also to be kept in mind, if any large-scale use of chemicals is envisaged for weed control purposes. In fact it may be said that even in the advanced countries of the West, real knowledge on the fundamental aspects as to how exactly these hormone chemicals act on plants, to bring about such multifarious effects ranging from weed control to prolonging the cold storage life of fruits, has somewhat tended to lag behind their commercial exploitation for agricultural purposes.

The future prospect would seem to be a vigorous search for a chemical that would be as effective on grasses as 2 : 4–D is on broad-leaved weeds. The next development would be a particular best weedicide for a particular weed in a particular crop. Better formulations of herbicides to minimise spray-drift damage and increase lethal effect on weeds, are other desirable developments.

REFERENCES

1. Kalamkar, R. J. and R. B. Ekbote, 1953 — Proc. of the Ind. Sci. Congress. Part III, p. 147.
2. Lal, K. B., (1948) — Indian Farming, Dec. 1948, p. 493.
3. Mitra, G. P., (1948) — Science and Culture, 14.
4. Prasad, N., (1952) — Current Sci. **21**, (11) p. 325.
5. Scott - Padwick, G., (1948) — Indian Farming, Dec. 1948, p. 497.
6. Thomas, K. M. and A. R. Srinivasan, (1949) — Indian Farming, March 1949, p. 101 - 6.

Enzyme (Diastase) of Aspergillus oryzae and its Application to Malt Extract Production *

by

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I. **Introduction:** The method employed in the Government Malt Factory for the production of malt extract was by germinating cholam (*Sorghum durra*). Since the malted cholam contains comparatively little of the enzyme amylase, only about 20 per cent of the starch contained in the cholam grain is recovered as sugar (maltose). This tells on the cost of production of malt extract, besides the cost involved in the malting process where controlled conditions of temperature, humidity, constant attention etc., are necessary, for which special equipments in the form of air-conditioned couching chambers have to be maintained.

It has long been known that the fungus *Aspergillus oryzae* contains an enzyme of high diastatic power and, therefore, investigations on the enzymatic studies on *Aspergillus oryzae* were carried out to see its applicability to the production of malt extract. Because of its high saccharifying power (nearly four times that of malted cholam) it was hoped, that if a method was developed for the utilization of fungal diastase, the cost of production could be reduced considerably.

II. **Review of Literature:** The fungus was originally known as *Eurotium oryzae*, first being identified by Ahlberg in 1879, and later, Cohn renamed it as *Aspergillus oryzae*. O. Kellner and his pupils investigated the invertase, amylase and maltase content of it. Takamine, (1914) using wheat bran as culture medium, grew the fungus and gave the name "Taka-Koji" to it and used it as an amylo-clastic agent in fermentation industries. The chief advantage of using wheat bran instead of malt is that the cost of malt is subject to wide fluctuation according to the crop conditions. And secondly, the transformation of bran into "Taka-Koji" requires only about 48 to 72 hours while malting needs 3 or 4 times that period. Underkofler (1939) revived the idea of replacing malt with mold-bran in which the fungus elaborates the enzyme in the alcoholic fermentation of grains. Underkofler et al (1946) reported extensive commercial tests in which the yields of alcohol were as good or even better with mold-bran than with malt. The same authors (1947) reported successful commercial application of mold-bran for alcohol and syrup manufacture.

It is clear that the fungus is capable of producing diastase of very high efficiency; higher than that of barley diastase and has the added

*Paper awarded the Ramasastrulu Munagala Gold Medal on the College Day, 1954.

advantage of utilising various cheap by-products such as rice-bran, wheat-bran etc. for its growth for the production of the enzyme.

III. **Object of the Investigation:** It is known that cholam diastase is poor in comparison to barley diastase. It would certainly be advantageous to obtain diastase from the fungus and utilise it either alone or in combination with cholam diastase, whereby it might be possible to obtain greater yield of extract. Secondly, the cholam for malting should be of excellent quality. This is a factor to be considered when there is scarcity of grain with prevailing high cost. With fungus enzyme any kind of starchy flour can be used and, owing to the greater efficiency of the enzyme, the cost of production of malt extract could be reduced considerably.

IV. **Materials and Methods:** Preliminary experiments were conducted under the following heads:

(a) Selection of efficient strain of *Aspergillus oryzae* in regard to its diastatic activity.

(b) Selection of a suitable media for maintenance of the fungus.

(c) Comparing the efficiency of the two diastases, namely, cholam and fungal, after standardising the method of assay.

(d) Selecting the most suitable substrate for growing the fungus for the production of diastase.

(e) Working out the optimum conditions such as temperature, moisture, etc., for the growth of the fungus for best results.

(f) Developing a method for utilising the fungal diastase for production of malt extract.

(a) *Selection of efficient strain of fungus:* Strains possessing high diastatic activity were obtained from different places as shown in Table I below and their comparative efficiency tested.

TABLE I

No.	Details of isolate		Obtained from	Diastatic power. Lintner Units
1.	N. C. T. C.	558	Bangalore	93·63
2.	,,	598	England	87·50
3.	,,	965	England	73·48
4.	A. M. I.	16,266	U. S. A.	37·00
5.	,,	17,299	U. S. A.	53·04
6.	N. C. T. C.	595	New Delhi	123·00
7.	Isolated locally		Coimbatore	85·43

From the above test it is seen that N.C.T.C. 558 and 595 are the best and these were used in further experiments.

(b) *Selection of best media for maintenance of the fungus:* To maintain the fungus for work without deterioration of its activity a suitable medium was necessary. Standard media such as Brown's, Steinbergh's and Czapek's were tried for selecting a suitable one for the purpose. However these media were not suitable for the purpose contemplated. Therefore, a modified medium was prepared consisting of malt-extract, peptone and yeast water in addition to nitrogen, phosphate, sulphate and other mineral salts in traces.

(c) *Comparing the diastatic activity of the fungus.* (i) *Standardisation of assay technique:* The diastatic power of the fungus was estimated by three different methods, viz. (1) the method prescribed by A.O.A.C. (1935); (2) Ling's modification of Lunge and Keane's (1914) method and (3) by the method developed by Gore and Steele (1935).

Finally the A.O.A.C. method was adopted, after making certain modifications to suit the local condition, in all the experiments.

Assay in Brief: (i) *Cultivation of the fungus:* Wheat bran obtained locally from the bazaar was cleaned, dried and stored in kerosene tins. Samples of ten gram quantities were weighed out, 10 ml. of water added, sterilized, inoculated with five days old culture of the fungus grown on malt agar and incubated at 28°C for obtaining best growth in the bran. On the fourth day the diastatic activity was estimated as below.

(ii) *Extraction of the enzyme for assay:* The mold-bran (as it could be designated now) was spread on glass plate, samples of 5 gm. taken in a glass mortar, a few grams of washed sand added to it and with a small quantity of water was ground to a paste, transferred to a beaker and made up to 100 ml. to extract the enzyme. The solution was stirred frequently to disperse the enzyme uniformly in the liquid.

(iii) *Estimation of diastatic activity:* To 100 cc. of 2% starch solution kept at 55°C for 30 minutes with the addition of 5 ml. of sodium acetate buffer solution to maintain the pH at 4·8 (considered optimum for the enzyme), 3 ml. of the extracted enzyme solution were added. The flask was kept exactly for 1 hour when the enzyme action was arrested by the addition of 10 ml. of N/10 KOH solution.

The amount of maltose released by the action of the enzyme was assessed by titrating against 5 ml. of Fehling's solution and the diastatic power in Lintner units expressed by using the formula:

$\frac{1,000}{xy}$ where, x is the number of ml. of diastase solution added and y the number of ml. of the hydrolysed starch solution required to reduce 5 ml. of Fehling's solution.

V. **Results:** (i) *Comparative values of diastatic power of cholam and fungal diastases:* To test the efficacy of the fungal diastase for the production of extract it was compared with the enzyme of malted cholam.

Green cholam malt prepared in the Government Malt Factory at 65°F for 72 hours was used in the test. The values are given below:

TABLE II

	Substance	*Diastatic power in Lintner units at different temperatures*		
		28°C	40°C	55°C
1.	In Czapek's solution (mycelium)	Trace	Trace	Trace
2.	,, Liquid portion	2·01	3·23	3·77
3.	Grown on waste malt	16·55	30·54	33·71
4.	Green malt — (cholam)	14·22	26·69	34·36

The diastatic power of the fungus grown on waste malt was not greater than that of cholam malt. Other workers have reported very high diastatic power equivalent to barley malt and, hence, the reason for the low value was investigated into.

(ii) *Diastatic power of the fungus grown on rice and wheat brans with different sources of nitrogen.* The diastatic power of the fungus grown under controlled conditions on wheat bran, waste malt and rice bran with different sources of nitrogen was assessed and the results are given below:

TABLE III

	Substance	Diastatic power at 55°C 60 minutes Lintner Units
1.	Waste malt 10 gm. + 0·25 gm. Ammonium sulphate	33·71
2.	,, + 0·25 gm. Ammonium phosphate	33·71
3.	,, + 1 gm. groundnut cake	37·77
4.	,, 5 gm. + 0·5 gm. groundnut cake	51·45
5.	,, 2·5 gm. + 0·25 gm. groundnut cake	101·07
6.	Rice bran 10 gm. + 1 gm. groundnut cake	82·47
7.	,, 5 gm. + 0·5 gm. groundnut cake	56·14
8.	Wheat bran 10 gm. + 0·25 gm. Ammonium phosphate	114·18
9.	,, ,, + 1 gm. groundnut cake	140·13
10.	,, 5 gm. + 0·5 gm. groundnut cake	73·64
11.	,, 5 gm. + Rice bran 5 gm.	125·54

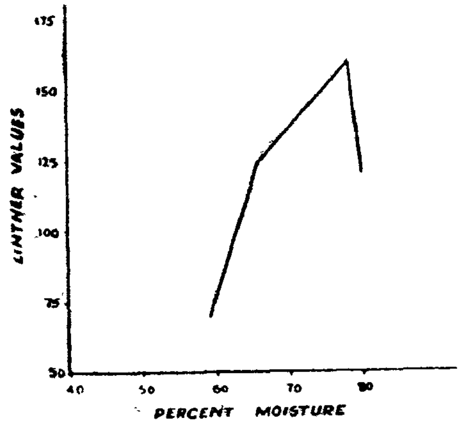
The following conclusions are drawn from the data obtained.

(1) The diastatic power of the enzyme produced by the *Aspergillus oryzae*, is far superior to that of cholam malt. The former is three to four times greater than that of the latter.

(2) Of all the substrates tried for the growth of *Aspergillus oryzae*, wheat bran has proved itself to be the best consistently in point of producing diastase of very high power.

GRAPH i

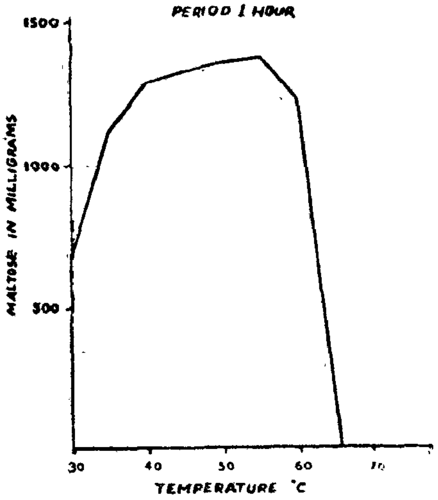
MOISTURE IN RELATION TO ACTIVITY OF THE ENZYME AT 55° 1 HOUR



GRAPH ii

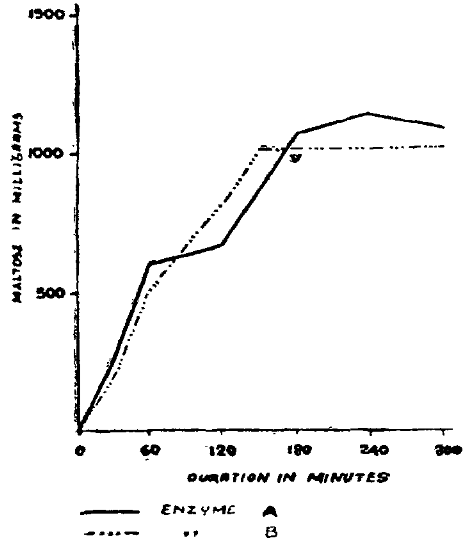
ENZYME ACTIVITY IN RELATION TO TEMPERATURE

PERIOD 1 HOUR



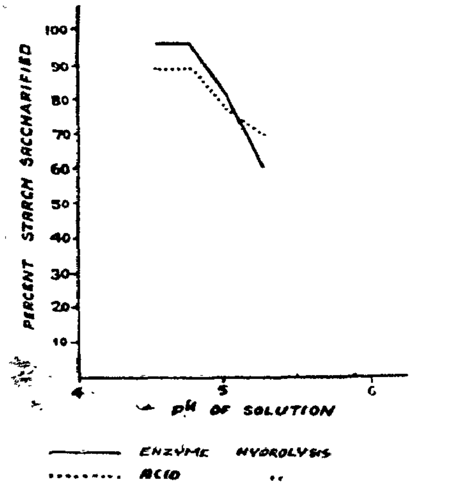
GRAPH iii

DURATION OF HYDROLYSIS & MALTOSE FORMED



GRAPH iv

COMPARATIVE EFFICIENCY OF ENZYME & ACID HYDROLYSIS



(3) The fungus makes good growth on waste malt. But, since this substance is practically three-fourths starch, the fungus utilises only a fraction of it and the rest is wasted.

(4) Rice bran as a substrate is not as good as wheat-bran Addition of wheat-bran in equal proportion increases its value.

(iii) *Utilization of other raw materials for the production of diastase:* Several previous investigators including Bindal and Sreenivasaya

(1944) have used wheat-bran, oil-cakes, cornmeal, crushed soya-bean meal etc. either as exclusive substrates or as supplements to the basal medium. Of the materials investigated wheat-bran has been found to be the substrate *par excellence* for the growth of *Aspergillus oryzae.*

For the production of enzyme a medium should be such that it will promote vegetative growth in abundance with a high diastatic content. The medium should not stimulate spore formation. Of the raw materials tried, besides wheat and rice-brans, those that have no feeding value but only valuable as fuel such as Ragi bhusa, dhall husk, groundnut shells etc. may be mentioned. They were used after pounding them to fine powder. But they do not compare favourably with wheat bran.

TABLE IV

Substrate	Lintner units
	55° – 60'
Groundnut bhusa	21·2
Ragi bhusa	15·8
Dhall husk	25·7
Ragi bhusa & groundnut cake	28·4
Dhall husk and groundnut cake	29·5
Wheat bran	82·6
Wheat bran & groundnut cake	112·4

(iv) (a) *Enzyme activity in relation to moisture content of the substrate:* To arrive at the optimum level of moisture necessary to moisten the bran for the best activity of the fungus; to 10 gm. portions of wheat bran in conical flasks water was added in varying amounts, sterilised and after the flasks were inoculated with fungal spores, they were incubated for 7 days at 28°C. The enzyme was extracted at the end of the period and its activity measured.

TABLE V

Enzyme activity in relation to moisture content of substrate

Moisture %	Lintner units 30 min. 55°C	Lintner units 60 min. 55°C
58	21·43	70·70
60	24·08	82·50
65	44·85	125·54
70	56·42	140·24
75	58·75	150·07
78	62·41	159·50
80	60·80	122·60

The activity of the enzyme is represented in graph I. The activity increases upto 78% moisture and drops at higher levels. Therefore it is clear that the bran should be moistened to 75 to 78 per cent level for the best elaboration of the diastase.

(b) *Enzyme activity in relation to time : (temperature constant.)* To find out how long the hydrolysis should be continued at a constant temperature for the maximum activity of the enzyme so that the greatest amount of starch could be saccharified.

A set of flasks containing 100 ml. of 2% starch solution was kept at 55°C. in a thermostat and the pH was adjusted to 4·5 by adding 5 ml. of sodium acetate buffer. The enzyme action was arrested at the specified period by adding 10 ml. of N/10 KOH solution and the maltose formed was estimated by the usual method. The results are given in Table below.

TABLE VI

Duration of hydrolysis and maltose formed at 55°C

Duration in minutes	*Maltose formed in mgm.*	
	Enzyme from sample A	Enzyme from sample B
30	275	245
60	600	519
120	653	818
180	1080	1013
240	1141	1019
300	1120	1025

From the data it is clear that the rate of saccharification is found to increase with the increase in time. The enzyme activity was practically same after three hours. The rate and course of action were almost identical when two different strains were used (vide graph iii).

(c) *Enzyme activity in relation to temperature:* Experiments with a view to find out the optimum temperature at which maximum of enzyme action takes place was carried out as below.

A set of flasks containing 100 ml. of 2% starch solution was adjusted to pH 4·8 and kept at temperatures varying from 30 to 70°C. for 1 hour and the maltose formed was estimated.

TABLE VII

Enzyme Activity in Relation to Temperature

(Period—1 hour)

Temperature °C	Lintner units 55°C 60 min	Maltose mgm.
30	76·2	700
35	125 9	1,157
40	142·2	1,306
45	146·9	1,350
50	149·4	1,373
55	152·0	1,396
60	137·7	1,266
65	trace	98
70	nil	nil

The activity of the enzyme increases steeply at first and steadily after 35°C. with the increase in temperature upto 55°C. and then declines rapidly. (vide graph ii). The maximum activity is thus seen to be around 55°C.

(v) *The effect of hydrogen-ion concentration of the substrate and enzyme activity.* It is well known that the optimum activity of the enzyme depends on the hydrogen-ion concentration of the solution with which it reacts. In order to select the level of pH of the solution for optimum activity of the enzyme an experiment was carried out and the data are given below. Side by side the acid hydrolysis of starch is given for comparing the efficiency of the enzyme with the acid hydrolysis.

TABLE VIII

pH of starch solution	Starch present	*Enzyme hydrolysis*			*Acid hydrolysis*		
		(a)	(b)	(c)	(a)	(b)	(c)
5·5 enzyme	6·741	4·574	4·117	61·07	5·208	4·687	69·54
5·0 ,,	,,	6·175	5·558	82·45	5·883	5·294	78·36
4·5 ,,	,,	7·265	6·539	96·98	6·822	6·001	88·98
4·0 ,,	,,	7·265	6·539	96·98	6·822	6·001	88 98
4·0 (control)	,,	Nil	Nil	Nil	—	—	—

(a) Sugar as maltose—gm.; (b) Starch equivalent—gm.
(c) Starch saccharified—%.

The maximum activity of the enzyme is between pH 4·0 and 4·5. At these pH, by the enzyme hydrolysis the saccharification is 96·98% while, by the acid hydrolysis it is only 88·98%. Thus it is seen that the activity of the enzyme is greater than that of the acid between pH 4 and 4·5. (Graph iv).

(vi) *Activators in relation to enzyme activity.* Some organic and inorganic substances such as amyl alcohol, ethyl alcohol, glycerol and iron, copper, manganese and zinc as catalysts were tried in small amounts as activators to speed up and enhance the activity of the enzyme.

No marked activity was noticed due to addition of the activators though there were differences among the several reagents tried in regard to their influence.

(vii) *The duration of fungal growth in relation to its activity:* To find out when the fungus attains its maximum activity in regard to the enzyme, the two strains of the fungus were cultivated on malt-agar and their activity measured daily from the 3rd to 6th day. The results are given below:

TABLE IX

Isolate		3rd day	4th day	5th day	6th day
N. C. T. C. 558	A	105·5	111·4	98·6	86·2
	B	112·57	114·5	75·6	85·4
N. C. T. C. 595	A	118·4	163·9	159·0	122·6
	B	138·9	161 5	150·1	119·5

(Values in Lintner units)

The diastatic power between third and fourth day is maximum and falls markedly later in both the cases.

VI. **Studies on the Utilisation of the Enzyme**: *Utilisation of mold-bran for the preparation of malt extract.* The saccharifying capacity of the mold-bran on the starch present in cholam, was examined as below.

Preparation of Mold Bran : The mold-bran was prepared by cultivating the strain selected for its best growth and high enzyme activity, namely isolate No. 595, on sterilised moistened wheat-bran to which 10% of groundnut cake was added. The fungus was allowed to grow in a dark place at room temperature for three days by which time the maximum of mycelial growth developed. (Used on the fourth day).

A sample of cholam, known as "Patcha jonna", was ground to a coarse flour and used for the experiments reported below.

(1) *The quantity of mold-bran for maximum saccharification of the starch present in cholam :* With the idea of finding out the quantity of mold-bran required in relation to the amount of cholam consistent with the maximum recovery of sugar the following experiment was carried out.

To 10 gm. lots of cholam flour 100 ml. of water were added and raised to a boil to mash the flour,. kept at that temperature for 2 minutes, cooled to 55°C and mold bran in varying quantities added and the action of the enzyme was allowed to proceed for one hour, boiled again for a few minutes to destroy the enzyme, filtered and sugar estimated in the filtrate. The results are given below :

TABLE X

Quantity of mold-bran	% Starch saccharified
1 gram	54
2 ,,	54
3 ,,	67
4 ,,	67
5 ,,	71
6 ,,	71
7 ,,	71
8 ,,	72
9 ,,	72

The best result obtained for the least quantity of bran was for 5 gm. of mold-bran.

The next step was to adjust the pH of the mash for, though the percentage of saccharification of the added starch was very high, it fell

short of the ideal which is 100%. Hence the pH was adjusted and the results are as below :

Mash acidified to pH	Per cent starch saccharified
5·5	61
5·0	82
4·5	97
4·0	97
4·0 (Control — No enzyme)	Nil

At pH 4·0 to 4·5 maximum hydrolysis of starch took place. Hydrolysis due to acidification of mash for pH adjustment was nil.

(b) *Gelatinising the starch present in cholam and saccharification* : Gelatinising the starch by boiling the cholam flour mash for a short while gave nearly three and a half times increased saccharification.

	Percent starch saccharified
Un-cooked	24·73
Gelatinised (cooked)	86·02

VII. **Practical Application of the Enzyme for Production of Malt Extract:** Preparation of malt extract with mold-bran was attempted as given under.

(1) *Method:* One pound of cholam, ground to a coarse flour, was cooked in water to gelatinise the starch, the mash kept at 55°C, pH adjusted to 4·5 with N/10 sulphuric acid and half-a-pound of mold bran (3 days growth) added. The hydrolysis was continued for 3 hours. After hydrolysis the liquid portion was separated by filtration through a muslin cloth and enough lime water to neutralise the sulphuric acid and precipitate it as sulphate of lime, was added (litmus test). Then 2 gm. of activated carbon for every 100 ml. of filtrate was added and filtered through activated carbon. The clear fluid was concentrated to a thick syrup of specific gravity 1·40 by evaporation under reduced pressure. The consistency of the extract, colour, flavour etc., were all perfect in every respect but there was slight bitterness in taste.

(2) *Bitterness and its removal:* The cause of bitterness was traced to the wheat bran. Apparently it contains some bitter principles that is responsible for the taste. The following experiment was carried out with a view to removing the bitterness in the final extract.

(i) Wheat bran cooked in 5 times its weight of water, the water discarded and the bran washed several times.

(ii) Wheat bran shaken for 1 hour in a shaking machine with 5 times its weight of water, the water thrown out and the bran washed well in several changes of water.

(iii) Wheat bran soaked in 5 times its weight of water overnight, the water thrown out and the bran washed in several changes of water.

The wheat-brans receiving pre-treatment as stated above were used in separate lots as substrate for growing the fungus and used for saccharification.

It was noticed that the extract obtained from the above treatments were all free from bitterness. Hence the simplest of the treatments, namely, soaking the wheat-bran in water over-night, removing the water and washing the bran in several changes of water was adopted as the best method. But, wheat bran when washed did not support the best growth of the fungus. An experiment was carried out to remedy this defect as per plan below:

Treatments.

(a) Wheat bran not washed (control)
(b) ,, plus 10% groundnut cake
(c) ,, washed
(d) ,, washed plus 10% groundnut cake
(e) ,, washed plus 1% starch.
(f) ,, washed plus 1% groundnut cake plus 1% starch.

The diastatic power was determined in the usual way and the following conclusions arrived at —

(i) Washing the bran prior to inoculation considerably reduced the diastatic power. This was due, mostly, to the poor growth of the fungus on washed bran.

(ii) The poor growth in the washed bran is presumably due to the removal of starch from the bran, since, the addition of starch restored the activity of the fungus.

(iii) Probably the growth promoting factors if any that were lost by washing were available to the same extent in the added cholam flour to support best growth.

(3) *Final method evolved to produce malt-extract:* Laboratory scale preparation was attempted by finalising the method of malt extraction as outlined below: To the washed wheat bran 1% of cholam flour was added, the fungus cultivated and this bran was used for saccharification of cholam flour. The cleaned cholam was slightly roasted, ground into a coarse flour, water (five times that of cholam) added, mashed after boiling for a while at 55° C. and the mold-bran (3 days growth) added. After three hours of hydrolysis the liquid was filtered through activated carbon. To the filtrate, small quantity of sodium bicarbonate solution was added. The hydrolysate was made neutral by the addition of calcium hydroxide (litmus test) and filtered and evaporated under vacuo. The extract produced in this way had a transparent amber colour, sweet taste and pleasant aroma. With

the knowledge and experience gained by these preliminary studies, semi-pilot scale preparation of the extract was made from cholam flour successfully which had excellent keeping quality.

Summary and Conclusions: A method for utilising fungal enzyme (diastase) for the preparation of malt extract in place of germinated cholam, with a view to reducing the cost of production of malt extract, was developed, and it was found that the fungal diastase can very well replace cholam malt for the production of extract. The fungus is cultivated easily on cheap by-products like wheat bran and no laborious or time consuming process is involved in the method. The cost of production comes to about a third of the method that had been employed in the malt factory. The extract prepared was fine in all respects and kept well for a considerable time. The studies revealed that the fungal enzyme can, therefore, be utilised for the production of extracts on a large scale at a cheap cost.

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BIBLIOGRAPHY

1. A. O. A. C. (1935) — 4th Edn. XIV, 46 - p. 158, Washington.
2. Beresford, H. and Christensen, L. M. (1941) — Idaho Agr. Expt. Sts. Bull 241.
3. Bindal, A. N. and Sreenivasaya M. (1944) — Sci. and Ind. Res., Vol. 3, No. 6, p. 245.
4. Gore, H. C. and Steele, H. K. (1935) — J. Ind. Eng. Chem. Anal. Ed. 6, No. 5, 324 - 328.
5. Hao, L. C., Fulmer, E. L. and Underkofler, L. A. (1943) — J. Ind. Eng. Chem. 35 : 814 - 818.
6. Hao, L. C. and Jump, J. A. (1945) — J. Ind. Eng. Chem. 37 : 521 - 525.
7. Lunge, G. and Keane, C. A. (1914) — Gurney & Jakson, London, Vol. III, part 2, p. 697 - 698.
8. Takamine, J. (1914) — Ind. Eng. Chem. Vol. VI, p. 824.
9. Underkofler, L. A., Fulmer, E. L. and Schone, L. (1939) — Ind. Eng. Chem. Vol. 21, No. 6, p. 734 - 738.
10. Underkofler, L. A., Severson, G. M. and Goering, K. J. (1946) — Ind. Eng. Chem. Vol. 36, No. 10, p. 980 - 85.
11. Underkofler, L. A., Severson, G. M., Goering, M. J. and Christensen, L. N. (1947) — Cereal Chem. XXIV, No. 1.

Symposium:

Recent Advances in Agricultural Extension Work

Abstract of the speech delivered by

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Within the past few years and consequent on the intensive methods for growing crops, extension work in Agriculture has seen some rapid and remarkable progress in Madras. One most note-worthy feature in the development is the supply of improved seed. Formerly the Department used to distribute a large quantity varying from eight thousand to ten thousand tons of primary and secondary seeds to ryots. This took a long time as well as considerable expense in procurement of secondary seeds. An important improvement made in the past few years by the Director of Agriculture was the supply of high grade paddy seeds and distribution to Village Seed Farms. In this method, only primary seed is multiplied by the Department and procured. This seed is distributed to selected members of the Agricultural Associations formed in each important village at the rate of one pound per acre and the entire quantity so produced is distributed by arrangement among the members of the Association, so that the whole village is covered by the improved seed, for each season. This method has the advantage of spreading the entire village in a very short period, as with one pound of primary seed it is possible to distribute 40 to 50 pounds to the Secondary Village Seed Farms. The method has got also the advantage that only high grade primary seed is handled by the Department, and the entire village is covered within three years from the nucleus seed, instead of four years and more now taken.

A similar development in Extension Work has also taken place in the direction of organising growers. For this purpose, the Agricultural Department has formed an Association for every important village and so far sixteen thousand villages have formed Village Agricultural Associations out of a total of twenty thousand villages in the State. By this method it has been possible to have full association of growers in all agricultural extension work. It is particularly the object of the Government of India, as well as the Government of Madras that Associations of Agriculturists are encouraged to distribute improved seeds. The method of Village Seed Farms for paddy and millets utilises the services of Agricultural Associations fully for this purpose, and the work is done extensively over a wide area, as well as intensively in each village. With a small quantity of seed, like two thousand tons, it is possible to develop the entire villages, where formerly ten thousand to twelve thousand tons

were required. This rapid development in quality as well as efficiency of distribution of improved seed has been a special feature of the recent advances in Agricultural Extension in Madras State.

The most significant feature of the recent advances in agricultural extension is the large amount of work involved and its turn-over. In Madras, the target for Sesbania as green manure was one million acres this year, and the achievement nine lakhs of acres, while the target for next year is one and half million acres, for which seed supply has already been programmed. Similarly, the target for ammonium sulphate is one and half million acres. Such large scale attack on agricultural improvement has been brought about by a careful planning in advance in the production side, followed by distribution and organisation in the villages. The work done on green manure in Madras to cover one million acres more every year is unique and has not been done anywhere in India or in any other country. A similar work is being done on *Glyricidia maculata,* which in the past few years has been extended to over five million plants, while every year three million plants are being arranged and systematically developed by the Agricultural Department.

This large extension on agricultural work through millions of acres has been rendered possible by the system of fixing up targets. which is also a recent development, consequent to the intensive production schemes. These targets are not only drawn up for the whole State, but for every unit and for every member of the staff to whom the targets are distributed so that the work can be watched and executed. Recently, the development has been given a very intensive shape and even village targets have been fixed up for such items as improved seed and distribution of Seed of Sesbania and *Glyricidia maculata.* In Tanjore Extension scheme, where the staff has been intensified at the rate of one Demonstrator for each Firka, instead of one Demonstrator per taluk, the work is expanding rapidly. Against a target of 730 villages, seed has been distributed to cover 700 villages individually, and this is also a remarkable feature of the recent advances in Agricultural extension.

Another feature is the large scale extension work being done in plant protection. This is particularly due to the availability of very useful insecticides like BHC and DDT and partly also to the organisation of the Plant Protection staff of the Agriculturat Department, to help the District and taluk staff in campaigns against paddy pests and diseases. During this year, insecticides and fungicides amounting to nearly 1,500 tons have been distributed and applied over an area of two lakhs of acres, Such an area has never been covered in any year before and this large scale attack has been rendered possible both by efficiency of organisation as well as the extension staff. In Madras another step of improvement is the 'forecast' service. Weekly forcasts of pests and diseases are

received from over 200 workers, and compiled by the Mycologist and Entomologist for taking prompt remedial measures. These forcasts are occasionally published in the Dailies but it will be useful if they are broadcast through the Radio.

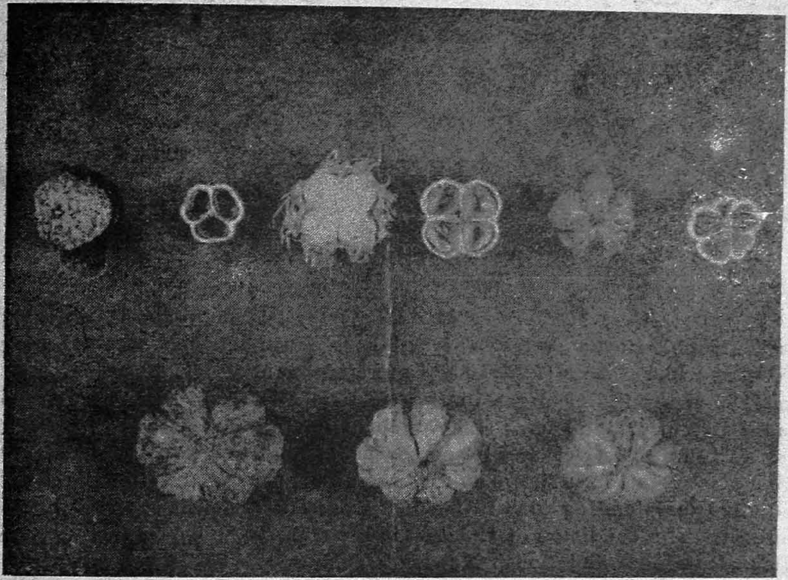
Much of the success is due to the intensification of these methods, and increasing the efficiency of work with the resources on hand. For this purpose, a planned programme of seed supply, as well as distribution is necessary. In the case of *Prosopis juliflora*, a very useful hedge plant, fifty thousand pounds of *Prosopis* was bought by the Department and this has been arranged to be distributed with the co-operation of the Railways, the Highways Department and the ryots over a very wide area. For expansion, twenty thousand miles of road and rail margins and about twenty thousand acres in the fields have been planetd to serve as fencing, as fuel and also as soil conservation plant. This plant, *Prosopis juliflora*, has got a large utility and the expansion of this plant over a wide area is due to the recent advances in Agricultural extension work.

The general trend in agricultural extension work is now towards greater efficiency in quality. Intensification of work through villages and large scale extended programme through organisation, is brought about with a minimum quantity, but over a maximum area in the shortest time. The recent advances, especially in *Sesbania*, *Glyricidsa* and *Prosopis* have all been made possible in the past few years because with a small quantity of seed, the ryot can be made to cover the whole of his area in a short time and become self-sufficient. Future work should also aim at the maximisation of work to every individual unit in a short period of time, so that the entire area is covered by agricultural improvements.

Research Note

Occurrence of Multi-Locular Fruit in *Ricinus communis*, L. (Castor)

The family Euphorbiaceae is characterised by its superior syncarpous pistil, usually three-celled and occasionally 3 or 4 celled ovary. Because of the generally three-carpelled condition this family comes under the order Thicoecae. *Ricinus communis* belonging to Euphorbiaceae has also generally three carpels with three styles and six stigmatic branches. The fruit is a schizocarp dividing into three cocci. Masur (1933) in the course of breeding work on castor, recorded 2, 4 and 5-celled fruits and observed that such cases were rare.



1. Top row — 3, 4 & 5 - carpelled fruits with cross section.
2. Bottom row — 6, 7 & 8 - carpelled fruits.

The authors of this note in the course of their study on castor came across a few multi-cellular fruits having 4, 5, 6, 7 and 8 carpels (vide figure). The number of stigmatic branches noted in these cases, was found to be double the number of carpels of the fruit, i.e., in a seven carpelled ovary fourteen stigmatic branches were noted. An extensive study revealed that the presence of multi-carpellary fruits was not confined to any particular type or variety. It was noted in many varieties of castor wherein one or two stray fruits alone were multi-locular while the rest were all normal three-loculled fruits. The seeds from these multi-locular capsules though normal in appearance, were slightly smaller in size. The plants raised from the seeds extracted from these multi-cellular fruits did not inherit this character.

Tho exact cause for the occurrence of multi-carpellary fruits is not known. The sub-tribe Acalypheae under which *Ricinus* is kept, has a few genera which have four carpels and *Maçaranga* six carpels. While the occurrence of six carpels in *Ricinus* is explainable, the presence of 7 and 8 carpels is rather baffling. *Hura crepitans* of Euphorbiaceae alone has many carpels.

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Agricultural Research Station, Tindivanam Dated 15—5—1954.

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Masur, N. G. (1933) — Agric. & Livestock Ind. 3 (2) : 128.

CROP AND TRADE REPORTS

Crop Statistics, 1953—'54, Madras State, Pepper — final forecast: The area under pepper in the districts of Malabar, South Kanara and the Nilgiris is estimated at 1,18,650 acres (1,02,000 acres in Malabar District, 16,500 acres in South Kanara District and 150 acres in the Nilgiris District). Compared with the estimated area of 1,14,900 acres (1,00,000 acres in Malabar District, 14,800 acres in the South Kanara District and 100 acres in the Nilgiris District) for the previous year, the present estimate shows an increase of 3·3 per cent. Compared with the previous five years ending with 1951—'52 the present estimate shows an increase of 17·6 percent. The condition of the crop is reported to be below the normal in the Districts of Malabar and South Kanara. The yield is estimated at 9,010 tons of black pepper (7,750 tons in Malabar District, 1,250 tons in South Kanara District and 10 tons in the Nilgiris District). Compared with the yield of 8,300 tons of black pepper (7,170 tons in Malabar District, 1,120 tons in South Kanara District and 10 tons in the Nilgiris District) estimated for the previous year, the present estimate shows an increase of 8·6 percent. Compared with the previous five years ending with 1951—'52 the current year's estimate reveals an increase of 12·2 percent. The wholesale price of black pepper per standard maund of 82-2/7 lb. or 3,200 tolas as reported from important market centres on 6th March 1954 was Rs. 220—6—0 in Mangalore, Rs. 214—4—0 in Cochin, Rs. 213—8—0 in Kozhikode and Rs. 205—12—0 in Tellicherry. Campared with the prices which prevailed in the corresponding period of the last year (i. e. on 7th March 1954) these prices reveal a a decrease of 40·5% in Mangalore, 40·7% in Cochin, 40·1% in Kozhikode and 42·1% in Tellicherry.

Bengalgram — Third and final forecast: The area sown with Bengalgram in Madras State in 1953—'54 is estimated at 6,400 acres. Compared with the actual area of 6,200 acres for the previous year and the average area of 5,200 acres for the previous five years, the present estimate shows an increase of 3·2% and 23·1% respectively. The increase in area this year is mainly due to favourable seasonal

conditions. The crop is not grown in the districts of Chingleput, Tanjore, Malabar, South Kanara and the Nilgiris. An increase in area is estimated in the districts of South Arcot, North Arcot, Coimbatore and Tirunelvelly and a decrease in the district of Ramanathapuram. The area was the same as that of the last year in Salem, Tiruchirapalli and Madurai Districts. The crop has been harvested in most of the districts. The yield per acre in the current year is estimated to be higher than that of last year in all the districts of State. The seasonal factor for the State as a whole works out to 96 percent of the normal as against 75 percent of the normal estimated for the previous year. On this basis the yield is estimated at 1,200 tons. Compared with the estimated yield of 1,000 tons for the previous year and an average yield of 800 tons for the previous five years, the present estimate shows an increase of 20·0 percent and 50·0 percent respectively. The wholesale price of Bengalgram per standard maund of 82-2/7 lb. or 3,200 tolas on 8—5—1954 was Rs. 24—1—0 in Salem. Compared with the price which prevailed in the corresponding period of the last year, this reveals a fall of 24·9 percent.

Redgram—Third and final forecast: The area sown with Redgram in the Madras State in 1953—'54 is estimated at 1,70,100 acres. Compared with the actual area of 1,34,500 acres in the previous year, it is an increase of 26·5 percent. Compared with the previous five years ending with 1952—'53, it is an increase of 9·5 percent. The increase in area this year is largely due to favourable seasonal conditions. The crop is mainly grown in the districts of South Arcot, North Arcot, Salem, Coimbatore and Tiruchirapalli. An increase in area is estimated in all the districts of the State except in the district of South Kanara, where the area in the current year is the same as that of last year. The area under the crop in the Nilgiris district is little or negligible. The crop has been harvested in most of the districts. The yield per acre is estimated to be higher than that of last year in all the district of the State. The total yield works out to 24,200 tons (cleaned gram) as against 15,600 tons (cleaned gram) estimated for the previous year and an average of 18,100 tons (cleaned gram) calculated from the previovs five years ending with 1952—'53 representing in increase of 55·1 percent and 33·7 percent respectively. The wholesale price of Tur dhall per standard maund of 82-2/7 lb. or 3,200 tolas as reported from important market centres on 8th May 1954 was Rs. 19—0—0 in Tiruchirapalli, Rs. 18—0—0 in Tirunelveli, Rs. 17—10—0 in Salem and Rs. 16—12—0 in Vellore. Compared with the prices published in the corresponding period of last year, that is, those which prevailed on 9th May 1953, these prices reveal a decrease of 18·4 percent in Tirunelvelly, 17·3 percent in Vellore, 13·6 percent in Tiruchirapalli, and 12·1 per cent in Salem.

Tobacco—Third and Final Forecast: The area sown with tobacco in the Madras State in 1953—'54 is estimated at 49,000 acres. Compared with the actual area of 45,000 acres for the previous year and the average area of 45,200 acres calculated for the five years ending with 1952—'53 the present estimate shows an increase of 8·9 percent and 8·4 percent respectively. The increase in area this year is due mainly to better seasonal conditions. The area estimated is the same as that of last year in the districts of South Arcot, and Tanjore, and an increase in the other districts of the State except in Chingleput, Malabar and the Nilgiris districts where the area is little or negligible. The crop has been harvested or is being harvested in parts of the State. The yield per acre is estimated to be higher than that of last year in all the districts of the State. The total yield works out to 28,400 tons of cured leaf as against 19,400 tons of cured leaf estimated for the previous year, representing an increase of 46·4 percent. Compard with the average yield of 20,500 tons calculated for the five years ending with 1952—'53 the present estimate is an increase of 38·5 percent. The wholesale price of tobacco per

standard maund of 82-2/7 lb. or 3,200 tolas as reported from imporant market centres on 15th May 1954 was Rs. 39—6—0 in Erode and Rs. 63—5—3 in Tiruppur. Compared with the prices which prevailed on 18th May 1953, these prices reveal an increase of 6·7 percent in Tiruppur and a decrease of 4·0 percent in Erode.

Sugarcane — Fourth and final forecast: The area planted with sugarcane in the Madras State during 1953—'54 is estimated at 1,16,500 acres. Compared with the final area of 80,290 acres for the previous year and an average area of 96,780 acres calculated for the five years ending with 1952—'53, this is an increase of 45·1 percent and 20·4 percent respectively. A decrease in area is estimated in the district of Malabar and an increase in area in the other districts of the State except in Tirunelvelly where the area estimated is the same that of the last year. The area under the crop is little or negligible in the district of the Nilgiris. The crop has been harvested or is being harvested in many districts. The yield per acre is estimated to be higher than that of last year in all the districts of the State. The total yield works out to 3,076,360 tons of cane, the gur equivalent of which is 3,37,230 tons as against 19,42,410 tons of cane with a gur equivalent of 2,14,400 tons estimated for the previous year representing an increase of 57·3 percent. Compared with an average yield of 23,86,520 tons of cane with a gur equivalent of 2,61,820 tons calculated for the five years ending with 1952-'53, the present estimate shows an increase of 28·8 percent. The average wholesales price of Jaggery per maund of 82-2/7 lb. or 3,200 tolas at important market centres on 8th May 1954 was Rs. 17—2—0 in Mangalore, Rs. 15—10—0 in Salem, Rs. 14—10—0 in Tiruchirapalli Rs. 13—2—0 is Erode. Compared with the prices which prevailed in the corresponding period of the previous year, these prices reveal a fall of 36·7 percent in Tiruchirapalli, 37·0 percent in Mangalore, and 20·9 percent in Salem.

Potato—Second Forecast Report: The potato crop is grown mainly in the Nilgiris district and to a small extent in Salem and Madurai districts.

The area under the crop upto 25th May 1954, is estimated at 23,300 acres. Compared with the final area of 20,050 acres for the previous year, this shows an increase of 16·2 per cent.

Winter Crop: The area under the winter crop of potato is estimated at 4,550 acres as against the final area of 4,030 acres for the previous year, representing an increase of 12·9 per cent. The yield per acre is estimated to be higher than that of the previous year in the districts of Salem and the Nilgiris. The Seasonal Factor for the State as a whole works out to 99 per cent of the normal as against 90 per cent estimated for the previous year. On this basis the total yield works out to 14,190 tons as against 11,370 tons estimated for the previous year, representing an increase of 42·8 per cent.

Summer Crop: The area under summer crop is estimated at 18,750 acres as against the final area of 16,020 acres for the previous year, representing an increase of 21·1 per cent. An increase in area is estimated in the districts of Madurai and the Nilgiris. The area under the summer crop in the Salem district being little or negligible. The condition of the standing crop is reported to be generally fair.

The wholesale price of potato per standard maund of 82 2/7 lb. or 3,200 tolas at Madras on 15—6—1954 was Rs. 16—8—0. Compared with price which prevailed in the corresponding period of the previous year (i. e. on 15—6—1953), this is a decrease of 21·8 per cent.

Weather Review — For the month of August, 1954.

RAINFALL DATA (IN INCHES)

Division	Station	Total rainfall for the month	Departure from normal	Total since 1st January
North	Madras (Meenambakkam)	2·8	— 1 8	16·9
	Tirurkuppam*	5·5	+ 0·6	19·2
	Vellore	2·9	— 2·8	18·9
	Gudiyatham*	7·0	+ 2·7	28·6
East Coast	Palur*	5·0	— 0·5	21·4
	Tindivanam*	5·4	+ 1·0	25·2
	Cuddalore	5·9	+ 1·1	25·0
	Nagapattinam	2·7	+ 0·4	14·6
	Aduturai*	8·0	+ 3·4	19·7
	Pattukottai*	12 8	+ 9 5	32·0
Central	Salem	6·8	+ 0·2	23·9
	Coimbatore (A. M. O.)*	1·6	+ 0·2	15·3
	Coimbatore	0·7	— 0·5	17·5
	Tiruchirapalli	7·6	+ 3·8	20·8

Division	Station	Total for the month	Departure from normal	Total since 1st January
South	Madurai	12·4	+ 8·3	25·8
	Pamban	0·8	+ 0·2	12·7
	Koilpatti*	2·4	+ 0·2	21·6
	Palayamcottai	0·3	— 0·4	10·7
	Ambasamudram*	0·4	£	19·9
West Coast	Trivandrum	6·1	— 0·6	41·9
	Fort Cochin	14·2	+ 0·3	97·5
	Kozhikode	21·1	+ 4·0	126·5
	Pattambi*	12·0	— 1·0	76·4
	Taliparamba*	27·6	+ 5·4	136·4
	Wynaad*	16·7	+ 3·7	67·5
	Nileshwar*	31·8	+ 8·5	158·2
	Pilicode*	31·5	+10·1	145·3
	Mangalore	26·7	+ 1·2	129·5
	Kankanady*	27·7	+ 4·4	129·9
Hills	Kodaikanal	6·7	— 0·3	41·8
	Coonoor*	4·4	+ 0·4	34·6
	Ootacamund*	4·8	— 0·2	26·2
	Nanjanad*	14·3	+ 6·5	45·9

Note :—1. * Meteorological Stations of the Madras Agric. Dept.

2. £ Actual deviation is + 0·04″.

The month began with fairly wide-spread rains along the West Coast and localised showers in Mysore, Andhradesa and Tamilnad. On the third day a depression formed in the Bay about 200 miles east of Calingapatam. In the subsequent three days the monsoon was active along the West Coast. On 7–8–1954 a shallow depression was noticed over North-west Bay of Bengal with its central region about 80 miles South-east of Puri. There was no large change in the behaviour of the monsoon till 11–8–1954, when it became feeble along the West Coast. It revived its vigour again on 14–8–1954 and remained so for a week. Again on 21–8–1954 it became weak. The fourth week of the month passed off with no major change in the behaviour of the monsoon. The monsoon strengthened in Central Bay of Bengal on 28–8–1954. Along the West Coast it was fairly active during the remaining four days of the month causing widespread rain in the locality and bocalised showers elsewhere in the region.

The note-worthy rainfalls and the zonal rainfall for the month are furnished hereunder :—

Note-worthy Rainfalls for the Month

Date	Name of Place	Rainfall	Name of Zone	Av. rainfall for July	Dep. from normal	Remarks
1/8/54	Kozhikode	4·0″	North	4·6	— 0·3	Just below normal
2/8/54	Mangalore	3·4″	East Coast	6·6	+ 2·5	Above normal
6/8/54	Mercara	6·8″	Central	4·3	+ 0·9	Just above normal
13/8/54	Tiruchirapalli	4·0″	South	3·3	+ 3·6	Above normal
28/8/54	Cuddalore	3 0″	West Coast	21·5	+ 1·1	Above normal
31/8/54	Bellary	4·0″	Hills	7·6	+ 0·4	Above normal

Agricultural Meteorology Section,
Lawley Road P. O.,
Coimbatore, 10—9—1954

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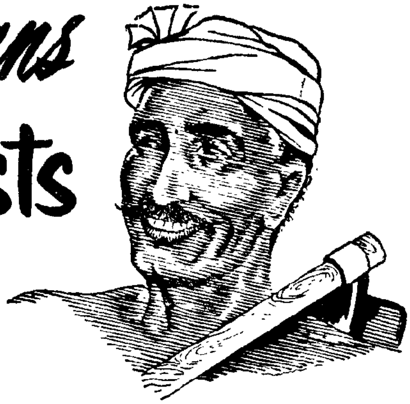

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	% ANALYSIS Nitrogen	Phos. Acid	Potash
P. S. Fertiliser Mixture	**16**	**4**	**Nil**
Packing	**80 lb. New Sealed Gunnies**		
A. P. Special Fertiliser Mixture	**14**	**7**	**Nil**
Packing	**80 lb. New Sealed Gunnies**		
N. P. K. Paddy Mixture	**12**	**6**	**6**
Packing	**80 lb. New Sealed Gunnies**		
Improved A. P. Special Fertiliser Mixture	**10**	**10**	**Nil**
Packing	**80 lb. New Sealed Gunnies**		
N. P. K. Paddy Ploughing Mixture	**8**	**8**	**8**
Packing	**80 lb. New Sealed Gunnies**		

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